



FDM 14-25-10 Pavement Rehabilitation Guidelines

May 15, 2019

10.1 General

These guidelines are intended to help determine the best method for rehabilitating pavements. **Pavement rehabilitation is a structural or functional enhancement that extends the pavement life, by significantly improving the pavement condition and ride quality.**

The recommendations presented are intended as general guidance for the pavement evaluation process and are not intended as absolute criteria applicable to all circumstances. Therefore, each project must be evaluated on its own merits.

An important preliminary activity is an assessment of the existing condition of the pavement. This assessment examines the International Roughness Index (IRI) and Pavement Condition Index (PCI) history and draws conclusions from that data. The assessment should also include a field survey of the project for evaluating pavement condition and estimating repair quantities.

A visual survey, **involving a field review of the pavement in person**, does have limitations. The level of distress at a joint or crack **may** not be fully determined simply by visual inspection of the surface. However, it is not in the scope of any one design project to core or perform nondestructive testing on every joint or crack to determine if there is underlying distress. Therefore, the designer must rely on resources such as PMDSS, the Concrete Pavement Rehabilitation Manual, and the limited coring performed on each project.

The base and subgrade conditions also play a significant role in performance. If serious base and/or subgrade problems exist, then a more extensive rehabilitation may be needed. Designers should request their **Regional** Soils engineer to drill soil borings and help determine the cause of the base or subgrade problems. If a more extensive rehabilitation level cannot be attained, a lower level of performance can be expected of the rehabilitation. It is **important** to determine the cause of the distress so that the correct rehabilitation strategy can be identified.

One of the key criterion governing the choice of a pavement rehabilitation strategy is the amount of existing pavement in need of repair. When the amount of repair necessary exceeds an amount economically feasible for the project, the pavement should be reconstructed. Each project should be evaluated individually utilizing Life Cycle Cost Analysis to determine if rehabilitation or reconstruction is most cost effective.

Typically, the term repair refers to a full depth procedure, except in the case of Partial Depth Repair. Just as typically, the term "patch" refers to a partial depth procedure.

10.2 Concrete Pavement

The second and third paragraph below were moved from 14-25-10.1.

There are several distresses in concrete pavements that justify a pavement rehabilitation. Some common distresses are transverse or longitudinal cracking, joint deterioration, and faulting. Concrete pavement rehabilitation methods used by WisDOT consist of full/partial depth repair, slab replacement, diamond grinding, and rubblization. More guidance on concrete pavement rubblization can be found in [FDM 14-25-15](#).

The May 1992 version of the Concrete Pavement Rehabilitation Manual ([Exhibit 10.1](#)) should be used as a resource for estimating repair quantities. This manual provides the methodology, based upon type and rehabilitation strategy, for the assessment of distresses in concrete pavements.

If *Concrete Pavement Repair* or *Concrete Pavement Repair SHES* are part of a project, designers should also consider including *Concrete Pavement Replacement* and *Concrete Pavement* bid items since unforeseen pavement patching/repairs may extend beyond 15 feet in length.

10.3 Hot Mix Asphalt (HMA) Pavement

There are several distresses in HMA pavements that justify a pavement rehabilitation. Some common distresses are alligator/fatigue cracking, centerline joint deterioration, reflective cracking, and rutting. Common methods of HMA pavement rehabilitation used by WisDOT are mill and overlay, Cold In-Place Recycling(CIR), and pulverization. More guidance on HMA pavement pulverization can be found in [FDM 14-25-20](#) and CIR in [FDM 14-25-25](#).

LIST OF EXHIBITS[Exhibit 10.1](#)

Concrete Pavement Rehabilitation Manual

FDM 14-25-15 Concrete Pavement Rubblization

May 15, 2019

15.1 General

The purpose of this procedure is to provide guidance on rubblization of concrete pavement. Further guidance can be found in [CMM 3-50](#). The use of crack/break and seat is not recommended on the state trunk highway system.

The objective of rubblizing concrete pavement is to produce a structurally sound base and to prevent reflective cracking in an overlay by destroying the integrity of the existing slab. This objective is achieved by fracturing the distressed concrete pavement in place, thereby reducing the concrete to rubble. The rubblized material acts as an interlocked unbound layer comparable to a high-quality aggregate base.

The rubblization process is applicable to Jointed Plain Concrete (JPC), Jointed Reinforced Concrete (JRC), and Continuously Reinforced Concrete (CRC) pavement. Reinforcing steel in JRC and CRC pavement must become debonded from the concrete to be successful and meet the performance expectations.

Rubblization, along with an HMA or concrete overlay, is considered pavement replacement. Conform with [FDM 14-15-10, Table 10.2](#) for standard rehabilitation scenarios.

15.2 Why Rubblize

Reflective cracking is a major problem in HMA overlays placed over intact concrete pavement, even when used in combination with other repair techniques (such as slab-jacking, partial and full-depth slab replacement, etc.). Reflective cracks can start to appear in the overlay within a few years after overlay placement. These reflective cracks then **should** be sealed and maintained to prevent further deterioration of the overlay. Rubblization addresses the reflective cracking problem by thoroughly fracturing the concrete pavement to produce a uniform, high quality base, thus eliminating slab action. Some benefits to rubblization include:

- Prevents reflective distresses in the overlay
- Recycles concrete into a high-quality base material
- Reduces or eliminates the need to haul the existing concrete
- Can be accomplished next to live traffic lanes
- Can be accomplished over existing utilities
- Can be accomplished in urban and rural situations
- Reduces time of construction

15.3 Selecting Rubblization Projects

Rubblization is an effective pavement replacement technique in many situations, but inadequate project scoping can lead to constructability problems. Proper project scoping should follow these steps:

1. Check the condition of the existing concrete pavement
2. Check for roadway features
3. Verify subgrade conditions

15.3.1 Condition of Existing Concrete Pavement

Determine the condition and distresses of the existing concrete pavement. Rubblization is considered a viable option when the concrete pavement has no remaining life – i.e., exhibits extensive structural distress along the project. **Remedial action may need to be performed on joints prior to rubblization. However, there may be cases where the pavement is far too deteriorated for rubblization to be used as a valid treatment, i.e, wide open joints, severe faulting.**

To maximize the initial construction investment of the concrete pavement, rubblization should be considered when one or more of the following structural deficiencies exist(s):

- Greater than 20% of the concrete pavement joints need repair
- Greater than 20% of the concrete surface has been patched
- Greater than 20% of the concrete slabs exhibit the “slab breakup” pavement distress
- Greater than 20% of the project length exhibits “longitudinal joint distress” greater than 4 inches wide

If delamination is present in the existing concrete pavement, additional breakage and/or equipment may be needed.

15.3.2 Roadway Features

Many conditions need to be addressed before rubblizing. The following is a non-inclusive list of roadway features that need to be addressed in the design phase:

- Matching into existing curb and gutter that will remain in place (milling is required)
- Cross-slope correction (milling or additional material may be required)
- Location of any utility structures, e.g., manholes, catch basins (positive identification for construction)
- Profile changes (check overhead clearances)
- Existing shoulder pavement structure (if required for handling traffic)
- Underlying rigid layer, e.g., bedrock, an old intact concrete pavement (additional breakage may be needed)
- Old/brittle underground utilities (gas lines, water lines, etc.) that are within 4 feet of the rubblized layer (requires detailed evaluation)

[FDM Chapter 11](#) contains additional feature constraints.

15.3.3 Subgrade Conditions & Drainage

Past construction practices of paving concrete pavement directly on subgrade or “weak” subgrade make rubblization susceptible to subgrade yielding problems during construction operations. Consult the Regional Soil engineer for guidance on classifying the soil and the assignment of a Design Group Index (DGI) value. Based on WisDOT research and experience, the rubblization construction process experiences difficulties with soil classified with a DGI greater than 12 (AASHTO A-6 & A-7 classification) or when the water table is less than 4 feet from the top of the existing subgrade. If the water table is less than 4 feet from the top of the existing subgrade, a more detailed investigation may be needed. Consult the Regional Soil engineer for guidance.

It is not statewide standard practice to use edge drains on rubblization projects. However, rubblizing the concrete slabs significantly increases the permeability of the concrete layer, and any surface water entering the rubblized layer can be removed through the use of edge drains, especially for pavements supported by fine-grained soils with low permeability. In areas with coarse-grained soils that have high permeability, edge drains are not typically needed. If a drainage system is desired, the edge drains and outfalls can be designed similar to typical drainage systems when open graded base course is used on a project. The use of drains in spot locations is an acceptable practice.

15.3.3.1 Edge Drains

When used, edge drains should be installed before rubblizing to ensure that there is sufficient time to allow the subbase and subgrade to drain and dry out. If edge drains are installed before rubblizing, attention must be paid to ensure that the trench is well compacted and protected. An HMA layer may be paved over the trench before allowing traffic next to the trench. If staging requires a high volume of traffic over the trench for an extended period, an HMA layer should be placed over the trench. Consult the Regional Soil engineer to determine any drainage needs of rubblization projects.

15.3.3.2 Subgrade Investigation

To help determine the foundation support conditions and strength before construction, a supplementary subgrade investigation can be performed. Falling Weight Deflectometer (FWD), **Ground Penetrating Radar (GPR)** and Dynamic Cone Penetrometer (DCP) testing are methods **used to** evaluate the current subgrade condition. FWD **and GPR** testing will provide information on subgrade uniformity, and the computed Resilient Modulus (M_R) values. DCP testing, which requires coring of the existing concrete pavement, will provide information on the subgrade bearing capacity. Contact the **Geotechnical Unit** supervisor at (608) 246-7940 to request **subgrade** testing for a project. For **the DCP** testing method, **the Department** recommends the following procedure:

Determine the base course thickness from as-built plans. Penetrate the rod of the DCP to the bottom of the base course, i.e. to the top of the subgrade. From that point, record the Penetration Rate (PR), in inches per blow, until a rock or other obstruction is hit or until the rod cannot go any deeper. The PR for that location can be an average or a common value of the individual recordings. Using [Figure 15.1](#), convert the PR to the California Bearing Ratio (CBR). Then, use [Figure 15.2](#) to determine whether the subgrade, rubblized concrete, and base aggregate layer provide enough support to accommodate the construction process, or whether any remedial action is required. Use the CBR value determined from [Figure 15.1](#) as the x-axis value for [Figure 15.2](#). The y-axis value can be calculated by adding the thickness of any existing base aggregate to the thickness of the

rubblized concrete pavement. The intersection of these values identifies a support relationship that is to be compared to the curve shown in [Figure 15.2](#). If the support relationship falls above the curve, then adequate support for construction is present. If the support relationship falls below the curve, then remedial improvements to the base structure are required. An intermediate base layer can be used to provide the required support.

Note that the figures could also be used in reverse order by first determining the minimum CBR needed, then determining the maximum penetration rate permissible to provide adequate support.

Each DCP test location along a project should be analyzed individually. The individual tests should also be compiled and the information looked at in unison to arrive at generalized project conditions for pavement design. Additional testing in soft/weak areas may be needed to determine the exact limits requiring remedial improvements.

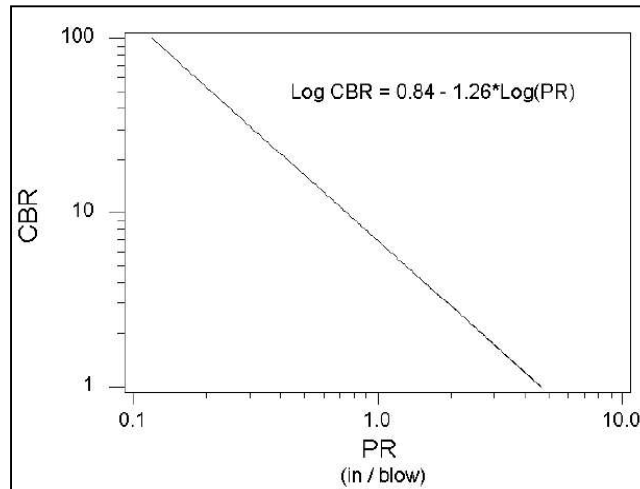


Figure 15.1. DCP Data Conversion to CBR

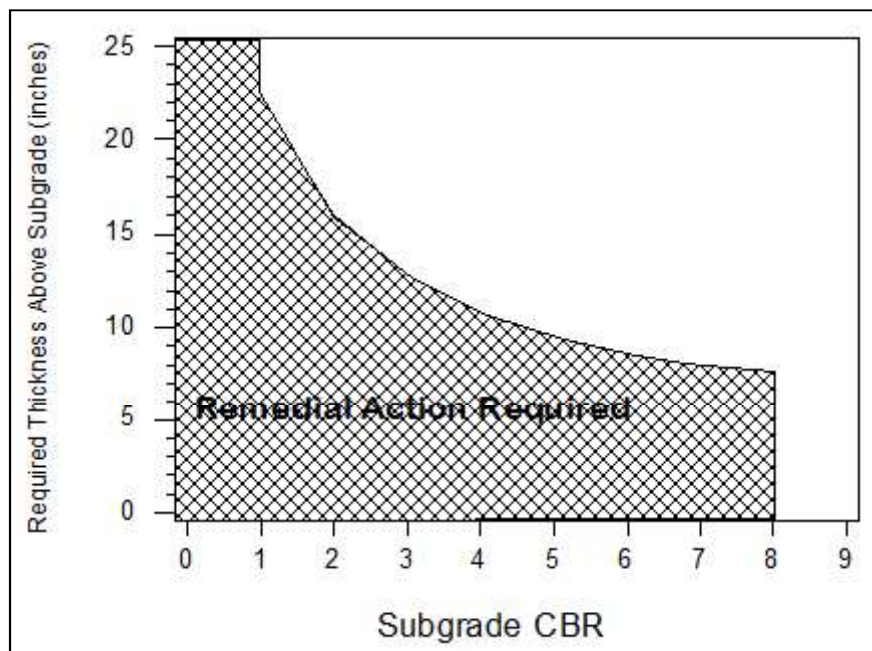


Figure 15.2. Subgrade/Base Layer Adequacy

For localized areas of poor stability, the specification allows for some modification to the broken particle sizes during construction. Excavation Below Subgrade (EBS) or increasing the overlay thickness are other possible solutions for these poor areas. It is important to remember that the rubblized layer must still provide a good working platform for paving operations and a stable foundation for the new pavement.

It should be noted that judgment is involved in determining existing and corrective subgrade needs. DCP and

FWD test results are dependent on the subsurface conditions at the time of testing and may differ from the conditions at the time of construction. The time of year construction occurs and the amount of rainfall during construction may have a large effect on subgrade stability.

15.4 Structural Design

WisPave is WisDOT's official software for pavement structural design.

15.4.1 HMA Pavement

When determining the HMA overlay thickness, both constructability and structural requirements of the rubblized pavement must be satisfied. The specific design input is the structural layer coefficient for each structural layer within the flexible pavement. The structural capacity of the entire pavement structure is represented using the Structural Number (SN) index, which is a sum of the product of the layer coefficient and layer thickness of all layers. The nationwide typical structural layer coefficient assigned to the rubblized layer is in the range of 0.14 to 0.30. Wisconsin policy is to use a range of 0.20 to 0.24.

The minimum HMA overlay thickness placed over rubblized concrete is 4 inches from a constructability standpoint. The first layer of HMA must be thick enough to adequately cover the rubblized concrete pavement and carry the expected construction traffic temporarily until the additional layers are placed. When making cross-slope corrections with the first layer of HMA pavement, maintain an adequate thickness at both the centerline and the edge of the pavement. Minimum HMA pavement layer thicknesses are found in [Standard Spec 460.3](#).

Estimated quantities for the first layer of HMA are to be calculated by using the following formula:

Width (ft) x Length (ft) x [(112 lb/SY/inch x Depth (inch)) + 20 lb/SY] x 1 SY/9 ft² x 1 ton/2000 lbs = _____ tons

This method adds 20 lb/SY to account for possible irregularities in the rubblized surface.

15.4.2 Concrete Pavement

Give credit to the rubblized material in the thickness design by increasing the k value, provided in the soils report, by an amount directly related to the thickness of the rubblized concrete pavement. [Table 15.1](#) indicates the increase in the k value for different thicknesses of rubblized material. These values should be interpolated for intermediate thicknesses. The modified k value should be used in WisPave to determine thickness design.

Table 15.1 Modified k Values for WisPave

Thickness of Rubblized Material	Increase in k Value
Less than 6"	0
6"	45
8"	90
10"	120
12"	150
16" and up	175

When placing concrete pavement over rubblized concrete, a bond breaker layer must be used. This should be a thin layer (about 1 1/2 inches) of asphalt treated permeable base, standard HMA pavement, open graded base, dense graded base. The purpose of the bond breaker is to allow for curling and warping of the concrete pavement. A bond breaker does not affect the structural coefficient of the rubblized material.

15.4.3 Intermediate Base Layer

The surface of the rubblized concrete layer cannot be bladed with a motor grader, but is generally suitable for paving over.

If an intermediate base layer is proposed to restore the grade, make cross-slope corrections, and/or to improve base support, the following materials (and associated bid items) can be specified:

ITEM NUMBER	DESCRIPTION	UNIT
305.0110	Base Aggregate Dense 3/4-Inch	TON
305.0115	Base Aggregate Dense 3/4-Inch	CY
305.0120	Base Aggregate Dense 1 1/4-Inch	TON
305.0125	Base Aggregate Dense 1 1/4-Inch	CY
306.0110	Salvaged Asphaltic Pavement Base	TON
306.0115	Salvaged Asphaltic Pavement Base	CY

An intermediate base layer should be a minimum of 4 inches thick for constructability purposes. Therefore, it should be accounted for in the structural design. The structural coefficient of the rubblized layer **should not exceed** the structural coefficient of the intermediate base layer material. **The layers of a HMA pavement structure are usually arranged such that the quality of materials decreases with increasing depth.** Rubblized concrete pavement is allowed a structural coefficient ranging from 0.20 to 0.24, and an intermediate base layer can consist of several materials ranging in coefficients from 0.10 to 0.25. Therefore, **depending on material used**, an intermediate base layer can decrease the structural coefficient of the rubblized material. ([FDM 14-10, Attachment 10.1](#))

When estimating quantities add 20 lb/SY to account for possible irregularities in the rubblized surface.

15.5 Structure Clearance

Often, special circumstances are required to accommodate overhead structure clearances. Each situation must be evaluated to determine which design will best provide long-term pavement performance while meeting project requirements.

Options available in these areas include reconstruction, partial-depth concrete milling and pavement inlay, or simply an overlay.

Some factors to consider are:

- Reconstruction: Existing elevations can be maintained or even lowered. Reflective cracking is eliminated.
- Partial-depth concrete milling and pavement inlay: This process can be completed quickly and under traffic. Existing elevations can be maintained. Reflective cracking of the overlay should be expected.
- Overlay: This process can be completed quickly and under traffic. The pavement elevation will increase but not as much as with the rubblize and overlay alternative. Reflective cracking of the overlay should be expected.

15.6 Other Considerations

Any existing asphaltic overlay must be removed before rubblizing the underlying concrete. This will require a separate bid item. Full-depth concrete pavement repair is not necessary. Full-depth asphalt patches, in good condition, may remain in place. Refer to [Standard Spec 335.3.3](#) for the removal requirements of other materials. **For severely deteriorated concrete joints not previously repaired, replace the joint with concrete base patching prior to rubblization or remove the joint and replace with base aggregate dense 3-inch.**

15.7 Staging

If staging is required for a rubblization project, special consideration must be given in certain areas.

15.7.1 Shoulders and Edge Drains

It is vital to protect the shoulders and edge drains. Following are three common staging scenarios along with a suggestion for protecting the shoulder and edge drains:

1. Roadway closed to traffic: edge drain system is installed, concrete is rubblized, and asphalt overlay is paved on travel lanes and shoulders before opening to traffic.
2. Construction with single lane closures and edge drains installed in advance of rubblizing and paving operation: the edge drain trench is capped either with HMA, crushed aggregate, or asphalt millings to provide an adequate shoulder before opening the adjacent lane to traffic.
3. Construction with single lane closures and edge drain installed just ahead of rubblizing: edge drain system is installed, concrete is rubblized, asphalt overlay is paved on the closed lane and adjacent shoulder before opening to traffic.
4. **Edge drains should be maintained to provide proper performance for the life of the pavement.**

15.7.2 Traffic Over Rubblized Concrete

The rubblized pavement should not carry traffic. It is best to provide traffic control that will not allow traffic to travel on rubblized pavement or on a thin layer of HMA over the rubblized pavement. If traffic must travel on one layer of HMA over the rubblized pavement, a sufficient HMA thickness must be in place.

If staging requires that traffic travel on an intermediate layer of HMA pavement before the full pavement is placed, consider providing an undistributed quantity of patching in the contract. Patching can be specified under one or more of the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
390.0103	Base Patching	SY
390.0201	Base Patching Asphaltic	TON
390.0203	Base Patching Asphaltic	SY
465.0110	Asphaltic Surface Patching	TON

15.7.3 Ramps and Intersections

Stage the rubblization and paving at ramps and intersections to maintain traffic flow. Require the contractor to provide proper traffic control.

FDM 14-25-20 HMA Pavement Pulverization

May 15, 2019

20.1 General

Pulverization is a pavement replacement technique that involves the in-place, full-depth pulverizing and mixing of an HMA pavement and a predetermined amount of the underlying base material. The objective of pulverization is to produce a structurally sound, homogeneous base and to prevent reflective cracking by reducing the distressed HMA pavement into a base material.

Pulverize and relay differs from mill and relay in that pulverize and relay cannot be performed on HMA pavements over concrete, whereas mill and relay can. The other major difference between the two techniques is the size of the reprocessed material. See [Standard Spec 325](#) and [Standard Spec 330](#).

Pulverization is considered a pavement replacement option. Conform with [FDM 14-15-10, Table 10.2](#) for standard rehabilitation scenarios.

20.2 Why Pulverize

Overlaying an HMA pavement may result in reflective cracking, premature pavement distress, and reduced overlay performance. Pulverization addresses these problems by reprocessing the entire HMA pavement in-place to produce a uniform, high quality base material.

Pulverization benefits include:

- Can be accomplished next to live traffic lanes
- Can be accomplished over existing utilities
- Can be accomplished in urban and rural situations
- Reduces or eliminates the need to haul material
- Provides a window of opportunity to fix localized subgrade problems
- Recycles HMA into a base material
- Provides a high-quality base material
- Prevents reflective distresses

20.3 Selecting Pulverization Projects

Pulverizing is an effective pavement replacement technique in many situations, but inadequate project scoping can lead to constructability problems. Proper project scoping should follow these steps:

- Check the condition of the existing HMA pavement
- Check for roadway features
- Verify subgrade conditions

20.3.1 Existing HMA Pavement

Any HMA pavement, except those directly on concrete, can be pulverized. To maximize the initial construction investment of the HMA pavement, pulverization should be considered after at least one rehabilitation cycle, or